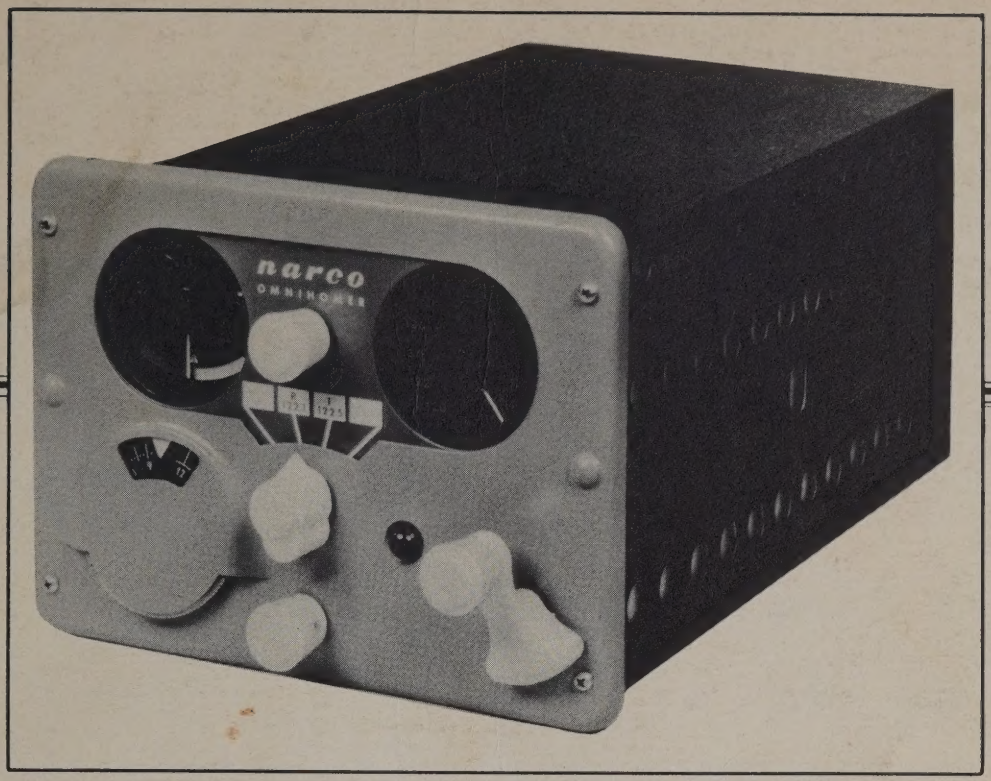

The *narco* VHT-1 OMNIHOMER

•

OPERATION · INSTALLATION and SERVICE MANUAL

•

MANUFACTURED BY
NATIONAL AERONAUTICAL CORPORATION
AMBLER • PENNSYLVANIA

•

Perfection in Electronics

Price $1.00

Warranty

We have designed and constructed this equipment using the finest materials and components available. It has been thoroughly tested and inspected before leaving our factory.

NARCO warrants your new VHT-1 against all defects of workmanship and material on components and parts manufactured by us for a period of ninety (90) days from the date of installation. We will furnish a new part in exchange for any part which proves to be defective within this time under normal installation use and service provided you return the defective part, transportation charges prepaid, either to the factory or to our authorized warranty Service Center. To place your warranty in effect you must fill out the warranty card supplied with set and mail it to us within ten (10) days after your new installation is completed.

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Section I · · · Operation

A. Receiver

A-1 Power Switch and Volume Control

The knob located at the lower center portion of the panel is the power switch and volume control. When turned fully counterclockwise all power to the set is off. Turning it clockwise first snaps on the power, and then increases the loudness of the received signals. The volume setting does not affect the operation of the omni-range circuits.

A-2 Tuning Dial

The dial is calibrated directly in megacycles from 108 to 126.5. Stations are tuned in the customary manner. The tuneable frequency band is divided as follows:

1. 108.1 to 111.9 ILS Localizers and VAR Radio Ranges.
2. 112.1 to 117.9 Omni-Range Stations (VOR).
3. 118.1 to 121.3 Airport Control Towers.
4. 121.5 Emergency Channel.
5. 121.7 & 121.9 Ground Control at Airports.
6. 122.1 to 122.9 Private Aircraft Stations (air to ground)
7. 122.8 Unicom (plane to plane and plane to small airport).
8. 123.1 to 123.5 Flight Test and Flying School Stations.
9. 123.7 to 125.5 Approach Control Stations.
10. 125.7 to 126.5 Air Carrier Stations.
11. 126.18 Military Tower Frequency.

The voice channel of the omni-range stations (heard without interference to the navigation function) carries a frequent station identification (in code) and also the usual range-station communications, such as airways traffic control, weather information, etc.

The control-tower stations function in a manner similar to low-frequency towers providing communication relative to take-offs, landings, etc.

A positive stop is provided at each end of the tuning range. Damage may result if the tuning crank is forced beyond the stops.

B. Transmitter

B-1 Channel Selector

The channel selector is in the central portion of the panel. It has 4 positions, which include the 122.1 mc. Airways Communications Channel, the 122.5 mc. Control Tower Channel, and two spare positions which can be activated to include any two channels between 121.5 mc. and 122.9 mc. See paragraph IV-C.

B-2 Modulation

The push-to-talk switch which is part of the microphone serves to place the transmitter in operation.

The front panel includes a transmitter output lamp. This lamp is lighted by a portion of the transmitter output power and serves as a positive indicator of actual transmission. It will light whenever the transmitter is radiating, but will not respond when the channel selector is set to an inactivated channel (one without a crystal). When speaking into the microphone, this lamp should flash somewhat brighter, in rhythm with the voice. In so doing it serves to inform the pilot that his microphone is functioning, and that he is speaking loud enough and close enough to it. Failure of the lamp to flash when speaking therefore indicates one or more of the following troubles:

1. Pilot not talking loud enough.
2. Microphone too far away from mouth.
3. Microphone or transmitter modulator not functioning properly (Some mikes will not operate well except when held upright).

B-3 Range

The range of reliable VHF radio transmission is limited to the approximate distance to the horizon. Therefore, the range increases rapidly as higher altitudes are attained. The table below will provide a basis for estimating the reliable range at various altitudes in flat country.

ALTITUDE	RANGE	ALTITUDE	RANGE
Zero	15 miles	5000 feet	60 miles
1000 feet	25 miles	7500 feet	70 miles
2500 feet	40 miles	10000 feet	75 miles

In mountainous country the reliable range depends upon a clear line-of-sight unobstructed by intervening mountains between the airplane and the ground receiving station.

B-4 License Notice

The operation of this radio transmitting equipment requires at least a third-class radio telephone operator's license which can be procured from any CAA flight examiner or FCC field office.

C. Omni-Range Navigation

C-1 Indicator and Indicator Switch

The indicating meter in the upper left portion of the panel serves both as a LEFT-RIGHT meter and a TO-FROM meter. The INDICATOR SWITCH which is in the upper center of the panel selects which function the meter is to perform, and indicates this selection by a flag which covers part of the meter scale in the TO-FROM position.

C-2 Course Selector

The course selector dial is located in the lower left part of the panel. It is rotated by its lower edge which is exposed. It is marked in 10° increments from 0° to 360°.

C-3 Course TO Station (Homing)

1. Turn the INDICATOR SWITCH clockwise until the TO-FROM flag snaps into position.
2. Tune to the desired omni-range on the receiver dial. The code identification will be heard. Tune for maximum deflection of the meter (either TO or FROM).
3. Rotate the COURSE SELECTOR dial until the meter deflects to maximum in the TO direction.
4. Turn the INDICATOR SWITCH counter-clockwise to snap the flag away from the indicating meter.
5. Reset the COURSE SELECTOR dial to center the meter needle. There will be two settings where the needle will center. The correct one will show a TO indication when the TO-FROM flag is momentarily snapped into view, and the wrong one will show a FROM indication.
6. Turn the airplane until the magnetic compass reads the same as the COURSE SELECTOR dial. The omni indications do not depend upon the attitude or heading of the airplane, but only upon its bearing from the ground station, and so will not change as the airplane is turned to the magnetic heading which corresponds to the bearing to the ground station.
7. Correct the heading from time to time as needed to keep the needle centered. The needle always points to the ground track to the station as shown by the COURSE SELECTOR dial (except when switched to TO-FROM).
8. When approaching close to the omni station, the needle may become so sensitive as to be difficult to hold to center. Notice the compass heading you have been flying

in the approach, and fly by compass until far enough beyond the station to make it easy to hold center again. By switching to TO-FROM during this interval, the time of passing the station will be indicated by several oscillations between TO and FROM after which the needle will continue to point in the FROM direction. After passing the station, reset the COURSE SELECTOR dial, if a new course is desired. Switch away the TO-FROM flag, and keep the needle centered as before. The sensing does not change.

9. If, for some reason, the airplane gets appreciably off-course as indicated by the needle, the COURSE SELECTOR can be reset slightly to recenter the needle. This will establish a new track to the station which is a straight line from the off-course point to the station, and is somewhat shorter than flying back to the original course.
10. The difference between the course setting as indicated by the COURSE SELECTOR and the magnetic heading of the airplane necessary to keep the needle centered, is the wind correction angle (plus any errors in the compass), which will be found useful in estimating the wind velocity and direction.

C-4 Course FROM Station

Any desired outbound course can be flown by setting the COURSE SELECTOR dial to the setting corresponding to the outbound course, and starting to fly in this direction. The needle will point to the chosen ground track, and when switched to TO-FROM will read FROM.

As the distance from the station increases, the signal will gradually grow weaker eventually reducing the needle sensitivity. When the signal becomes so weak that the code identification is getting noisy, and the needle will not deflect more than about 1/4 inch from center when switched to TO-FROM the courses are too weak to be reliable, and another stronger omni station should be found. It is well to check the receiver tuning when the signal gets weak to see that it is tuned for maximum signal.

C-5 Orientation

The OMNI-RANGE system can be used for orientation (obtaining a "fix" when airplane location is in doubt).

Bearings to ground stations do not depend upon the attitude or heading of the airplane, and hence can be taken easily and accurately in rough air. No compass correction needs to be made.

To use the omni system for orientation, the following procedure is recommended:

1. Choose two omni stations for bearings, which are as near 90° apart as possible, and which are strong enough to give reliable readings.
2. Tune in No. 1 omni station and check its code identification.
3. Rotate COURSE SELECTOR dial until meter centers in the left-right INDICATOR position, and reads FROM when switched to TO-FROM.
4. Record the reading of the COURSE SELECTOR dial, and draw a line on the chart FROM the omni station in the direction of this reading.
5. Tune in No. 2 omni station, take a FROM bearing, and draw a line from No. 2 station.
6. You are at the intersection of these two lines.
7. Add other lines from other omni stations, as desired, to improve the accuracy of the "fix".

D. Low-Frequency Receiver

(Accessory Item)

A compact sensitive low-frequency receiver known as the NARCO Model LFR-1, is available along with the VRP-31 CONVERSION KIT, which will add reception of range stations in the band 200 to 400 kilocycles, and broadcast stations in the band 550 to 1500 kilocycles.

When this conversion is included, a push-pull switch is installed on the front panel directly beneath the transmitter monitor lamp. When this small button is pushed in the VHF circuits are operative, and when pulled out the power is transferred to the low-frequency receiver.

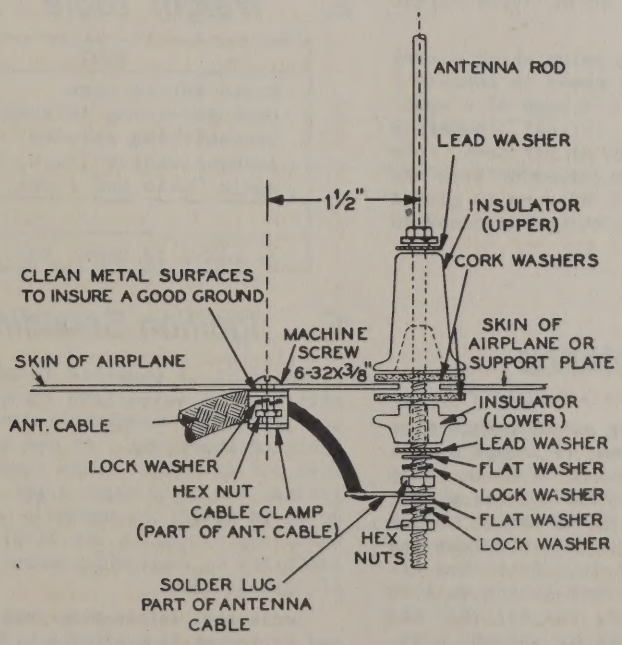


Figure 3 · TRANSMITTING ANTENNA · · MOUNTING DIAGRAM

Section II ··· Installation

A. VHF Transmitter-Receiver Unit (See Fig. 1)

1. Cut a rectangular hole in the instrument panel measuring 6 1/4 inches wide by 4 3/4 inches high.
2. Remove case from set, and install in this cut-out using machine screws and stop-nuts in the holes provided in the flanges. Set is held in case by a single wing nut at rear.
3. Install a rear support strap between the rear surface of the case, and some nearby structural member. An 8-32 machine screw projects from the rear of the case to use for this purpose. Be sure there are at least 2 inches behind the case to accomodate the various plugs and cables which connect to the rear of the set.
4. Slide the set into its case, and reattach rear wing nut and washers, tightening fully.

B. Omni Receiving Antenna (See Fig. 2)

The full range and accuracy of the VHF omni-range system can only be realized when the airplane is equipped with the proper type of antenna. For omni-range reception, a horizontal V-type antenna is absolutely necessary; a vertical whip is definitely not satisfactory, although it may appear to be when tried. Vertically polarized components are not radiated by the ground stations, but are produced by reflections from trees and similar objects. Therefore a vertical antenna may receive strong signals, but they are reflections and do not come directly from the ground station giving rise to very unreliable bearings.

The horizontal V antenna supplied with the set should be carefully installed preferably on top of the airplane behind the cockpit and well away from the engine and propeller. Some very successful installations have also been made on the lower surface of the fusilage, and on the top of the vertical stabilizer. The nose of the V should face directly forward or aft, and the rods should be horizontal in the level flight attitude.

The antenna mast contains a matching balun which serves as both an impedance transformer and a means to connect a coaxial line to a balanced V antenna. It is made of a special type of transmission cable cut to critical dimensions and should not be disturbed. If the mast is not used, this balun must be removed from it, and reinstalled between the antenna rods and the cable to the set. Be sure to ground all the coax sheaths at the point where the balun connects to the cable to the set.

C. VHF Transmitting Antenna (See Fig. 3)

The vertical whip type transmitting antenna should be mounted on a metal plate measuring at least 18 inches square for best results. Such a mounting surface is often found directly in front of the windshield in fabric-covered ships, and at the center of the cabin roof in metal ships. Where no such surface is available, a piece of thin aluminum may sometimes be affixed flush with the fabric. This thin aluminum sheet or foil may be made to conform to the various curved surfaces to which it is mounted, but all cuts and seams should be along lines radiating from the antenna base. A 7/16-inch hole should be punched in the center of this sheet for mounting the antenna. It is recommended that where necessary a metal reinforcing plate be provided to resist the bending load imposed by the slipstream. Do not lengthen or shorten the antenna. It has been cut the proper length for the most efficient radiation at the frequencies generated by this transmitter. The method of attaching the transmission line to the antenna is illustrated in Figure 3.

D. Cabling (See Fig. 4)

D-1 Antenna Cables

Both antenna cables are normally supplied as 8-ft. lengths of 52-ohm coaxial transmission line such as RG-58A/U. The lengths are not critical, but shortening or splicing this type of cable requires special techniques and should be avoided if possible. Extra long cables can be obtained on special order from the factory, complete with end fittings, or can be assembled in the field. Note that the receiver antenna cable has a phono-type connector on the antenna end and an auto-type connector on the set end. The transmitter antenna cable has a phono-type connector on the set end, and lug and clamp fittings on the antenna end. Thus the two cables are not directly interchangable at either end.

D-2 Audio Cable

The audio cable connects the mike and phone jacks as well as the speaker lead to the rear of the set. The cable can be shortened or lengthened as needed. The pin connections are as follows:

PIN	CONNECT TO	PIN	CONNECT TO
1	common ground	4	speaker voice coil
2	mike jack ring	5	phone jack tip
3	mike jack tip	6	---

D-3 Power Connection

The lead which extends from the rear of the set and includes a fuse holder should be connected to a point in the airplane's electrical system which can provide 13.5 volts at 10 amperes. The normal drain at this voltage is 4 1/4 amps (receive) and 4 1/2 amps (transmit). Battery voltages lower than 11.5 and higher than 15.0 can damage the vibrator and the set. When used with the LFR-1 Low-Frequency Receiver add 3/4 amp to above.

E. Weight Table

UNIT	WEIGHT
Radio Set in case	7.2 lbs.
Omni Receiving Antenna	1.9 "
Transmitting Antenna	0.2 "
Antenna Cables (both, 8 feet)	0.4 "
Audio Cable and Jacks	0.4 "
Total	10.1 "
If LFR-1 is used, add	2.0 "

F. Ignition Shielding

While it is possible in some types of airplanes to get satisfactory noise-free reception, it is always advisable and frequently absolutely necessary to use properly-fitted ignition shielding. It has been found that such shielding when not in first-class condition as to clean and tight joints, etc., can cause a lot of noise, particularly at VHF, so it is therefore urgently recommended that the ignition shielding system in the airplane in which the set is being installed be thoroughly inspected and overhauled at the time of installation.

Additional information regarding ignition noise shielding and filtering is available in NARCO Service Bulletin No.1003.

G. LFR-1 Low-Frequency Receiver (Accessory Item)

Detailed installation instructions are provided with this set. See paragraph IV-D of this manual for details of the conversion of the VHT-1 using the parts supplied in the VRP-31 CONVERSION KIT.

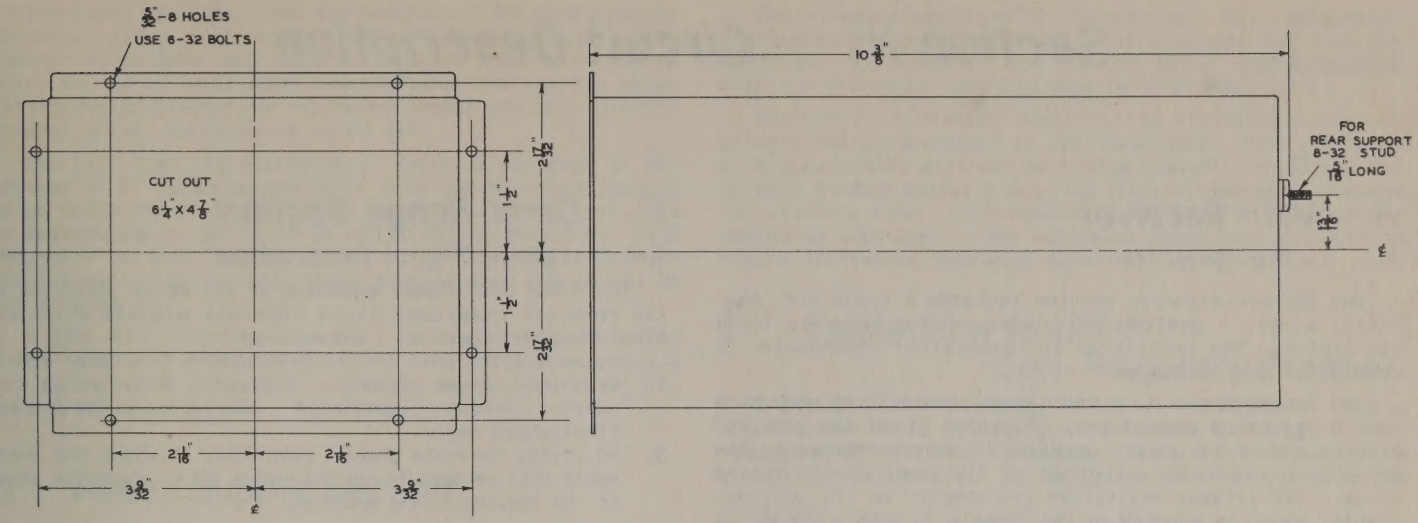


Figure 1 · VHF TRANSMITTER-RECEIVER UNIT · · MOUNTING DIMENSIONS

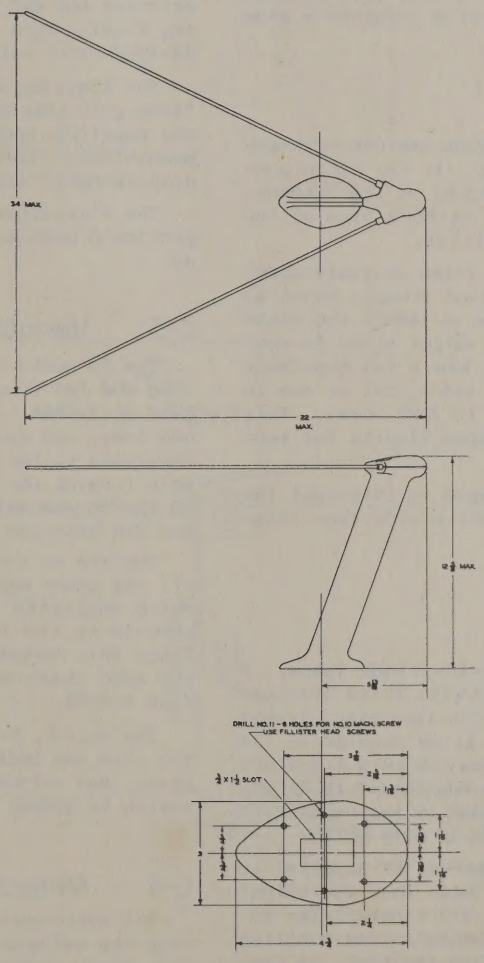


Figure 2 · RECEIVING ANTENNA · · MOUNTING DIAGRAM

Section III · · · Circuit Description

A. VHF Receiver

A-1 Pre-Selector

The VHF pre-selector section includes a tuned R.F. amplifier stage, a pentode converter, and a separate local oscillator. The oscillator is temperature compensated to keep drift to a minimum.

The tuning system is a three-gang permeability mechanism with a reduction gear drive. Positive stops are provided at each end of the range, arranged to prevent damage to the gears thru excessive pressure at the ends of the tuning range. The trimmer capacitors are mounted on the coil assembly, which is mounted on the chassis in such a manner as to reduce drift resulting from chassis strains, etc.

A-2 I.F. Amplifier – DET – AVC

Two stages of high-gain I.F. amplification are used peaked at 8.5 megacycles. A diode detector is used and the separate AVC diode is delay-biased to raise the detector level for improved linearity, and to flatten the AVC. The AVC time constant is somewhat slower than would be used for communication purposes, but the omni-range system requires a slow AVC to prevent curved courses.

A-3 Audio System

The first audio amplifier is a high-gain pentode arranged to receive the receiver detector signal via the audio control on its grid, and the microphone signal on its cathode. The mike current is derived from the cathode bias of the audio output stage thru a suitable filter.

The plate circuit of the first audio stage is resistance-coupled to the grid of the audio output stage, which is biased somewhat higher than normal so as to reduce the plate current drain. The plate of the audio output stage is connected to an output transformer which has a low-impedance winding tapped to match a 3-ohm speaker voice coil or one to four pairs of 600-ohm headsets (150 to 600 ohms). This transformer also includes a high-impedance winding for modulating the VHF transmitter.

The transmit-receive relay is arranged to interrupt the speaker lead in "transmit" and to insert a side tone dropping resistor in the phones lead.

B. VHF Transmitter

The VHF transmitter employs two twin-triode tubes. A conventional crystal oscillator is used with third overtone crystals at approximately 30 mc., and with its plate circuit tuned slightly above this frequency. It is coupled to the second half of the same tube which serves as a frequency doubler with its plate circuit tuned to approximately 61 mc. The 61-mc. tank is center-tapped and tuned by two capacitors so as to drive the two output tube grids in push-pull.

The two output tube plates are connected in parallel to the output tank which is tuned to 122 mc. Thus the output tube operates as a push-push doubler. The transmitting antenna is coupled to the output tank by a single-turn coupling loop. A similar loop, placed farther from the tank, is connected to a type 49 lamp mounted on the panel, which serves as a transmitter output and modulation monitor.

The audio gain of the speech amplifier and modulator is higher than normally required in order to utilize some speech clipping in the modulator so as to provide more effective communication.

C. Omni-Range Section

C-1 Omni Signal Description

The audio omni signal appearing at the second detector of the receiver comprises three separate signals which are simply mixed together. These are:

1. Voice modulation. 200 to 2500 cycles (35% max. mod.).
2. Reference phase signal. (30% mod.) 9960 cycles subcarrier, frequency-modulated ± 480 cycles at 30 cycles, fixed phase angle.
3. 30-cycle, variable phase, (30% mod.) in which the phase angle with respect to the reference phase signal is equal to the bearing to the station.

The omni-range circuits of the receiver are required to measure the phase angle between the 30-cycle variable phase signal and the 30-cycle fixed reference phase signal.

C-2 Reference Phase Channel

The 9960-cycle subcarrier component of the audio signal, which is frequency-modulated at a 30-cycle rate is amplified by the triode section of the tube which also contains the detector and AVC diodes, V-106. It is coupled to the limiter, V-201, thru a high-pass RC network to attenuate the 30-cycle and voice signals.

The limiting amplifier tube, V-201, is operated without fixed grid bias so as to saturate readily and thereby remove any amplitude modulation due to cross-modulation or propeller modulation. It operates the discriminator, V-202, thru a discriminator transformer, T-201.

The discriminator load is split into two equal halves to provide a push-pull input to V-203, the differential detector.

C-3 Variable Phase Channel

The 30-cycle component is taken from the second detector load and fed thru a 30-cycle RC type band-pass filter to the grid of V-204A. This tube has both a plate load and a cathode load, and provides three equal phases separated at 120° intervals to the course selector potentiometer. The components forming the phase-shifting network which couples V-204A to the course selector potentiometer are somewhat critical and are selected and compensated at the factory.

The arm of the course selector, which can be set to pick-off any phase angle between 0° and 360° is coupled to V-204B which amplifies this signal and feeds via an RC coupling network to the two grids of the differential detector. Since this network is carefully balanced, both grids receive the same phase and amplitude of the variable phase signal from V-204B.

The switch, S-201, short circuits a phase-shifting capacitor when the indicating meter is used for LEFT-RIGHT information, and introduces a phase shift approaching 90° when the switch is opened in the TO-FROM position.

C-4 Metering Circuits

The differential detector thus receives a push-pull signal from the reference phase channel, and a "parallel" signal from the variable phase signal. If these signals are exactly 90° apart in phase, they will add vectorially to the same total AC voltage on both grids, and will not cause the differential plate milliammeter to deflect. If, however, they are not exactly 90° apart in phase, the variable channel signal will increase the total AC voltage on one of the grids while reducing it on the other. This will cause an unbalance

in the plate currents to the two sections of the differential detector, which will cause the differential plate milliammeter to deflect away from the center. The direction in which the meter will move depends upon whether the phase relationship between the reference signal and the variable channel signal is above or below 90°.

The fact that the differential detector balances at 90° instead of 0° is compensated by rotating the three phases which drive the course selector potentiometer by 120°, and by introducing a -30° shift in the RC filter networks. Thus the meter is made to center for a 0° phase angle between the reference and variable phase signals when the course is set to read 0°.

A 2000-Mfd. damping capacitor is connected across the meter to slow its response so as to take an average reading and thus prevent it from fluctuating rapidly enough to become difficult to fly.

D. Power Supply Section

The power supply employs a high-frequency vibrator with a vacuum tube rectifier. The primary input circuit includes a hash filter and a high-capacity electrolytic capacitor to aid in supplying the peak currents required by the vibrator system.

The vibrator operates at 180 cycles. All replacement vibrators must be identical to the original and bear the NARCO part No. K-64004. This vibrator is NOT INTERCHANGEABLE with the 115-cycle vibrators used in other NARCO sets.

The buffer or timing capacitor is divided between the primary and the secondary of the transformer. This placement of a substantial part of the timing capacitance across the primary winding prevents starting difficulties and increases the vibrator life. Replacements for either timing capacitor should be identical to the originals since they are held to closer tolerances than most capacitors of their types.

E. Connection to LFR-1 Low-Frequency Receiver

A kit of parts to enable the VHT-1 OMNIHOMER to supply a power and audio system for the NARCO Model LFR-1 LOW-FREQUENCY RECEIVER is available, identified as the NARCO VRP-31 CONVERSION KIT. See paragraph IV-D for installation details.

The VHT-1, when so converted, includes a push-pull selector switch for connecting the plate supply to either the VHF receiver circuits or to the LFR-1 set. The VHT-1 power supply is not designed to supply both loads at one time, so the selector switch must be used.

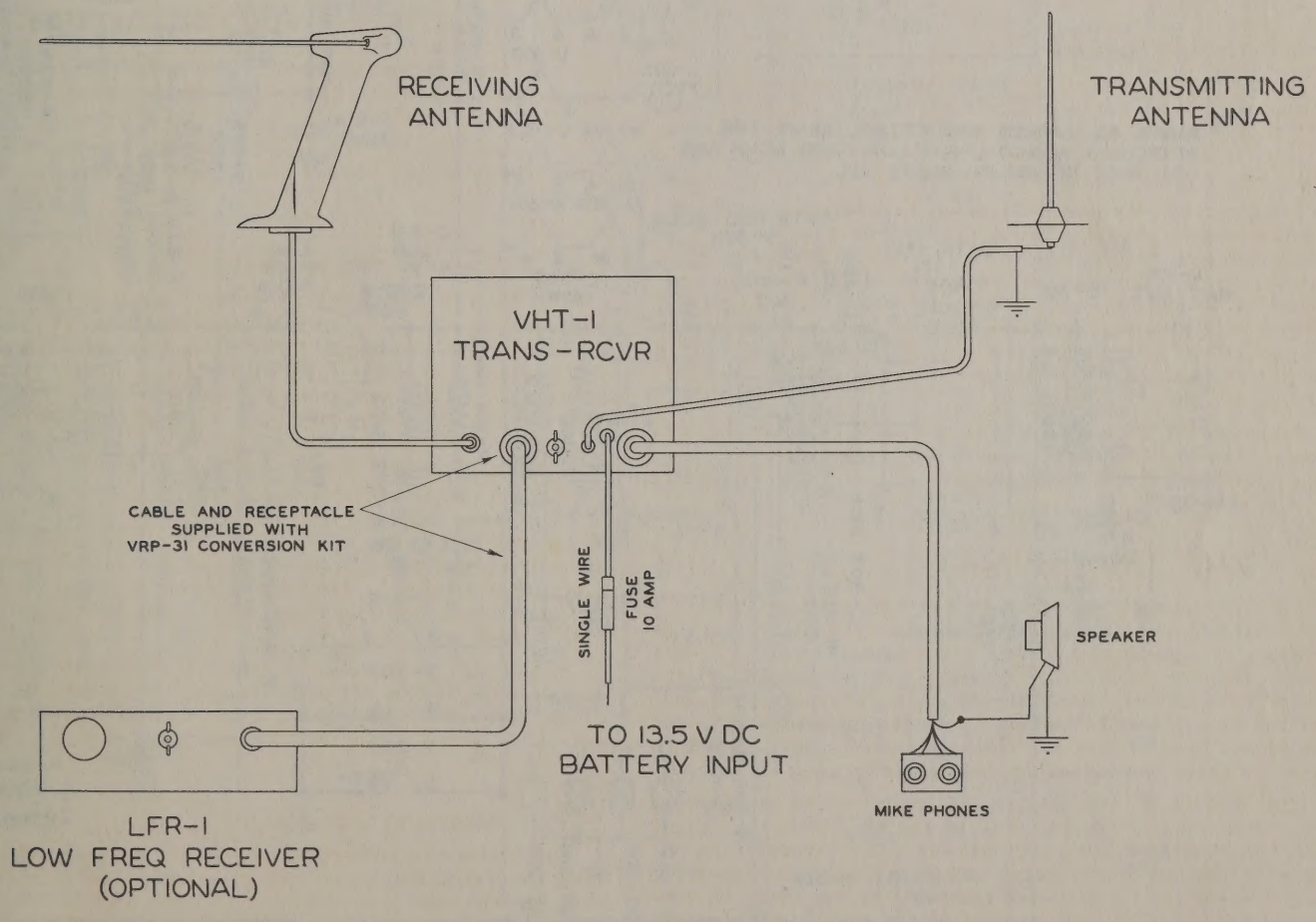


Figure 4 · CABLING DIAGRAM

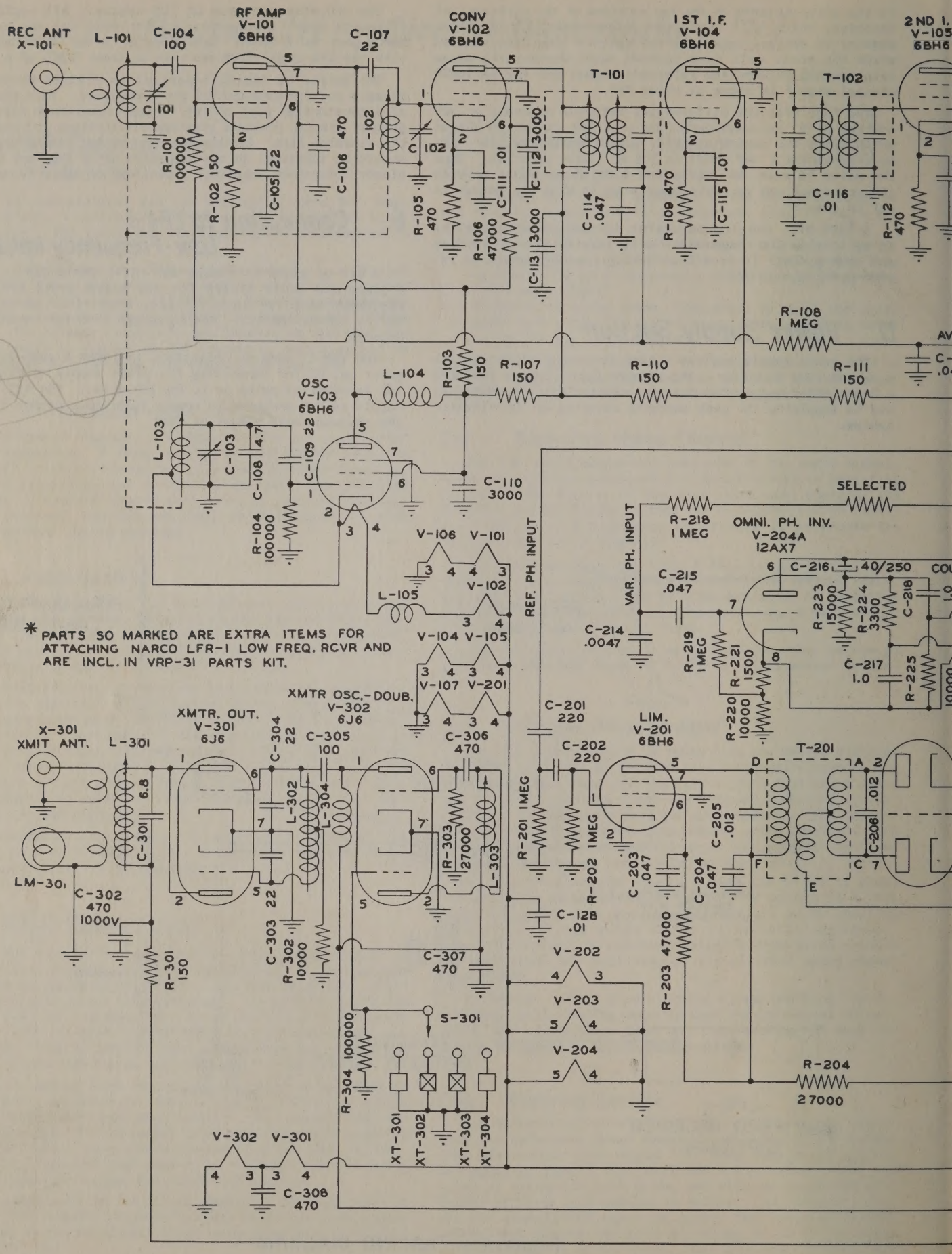
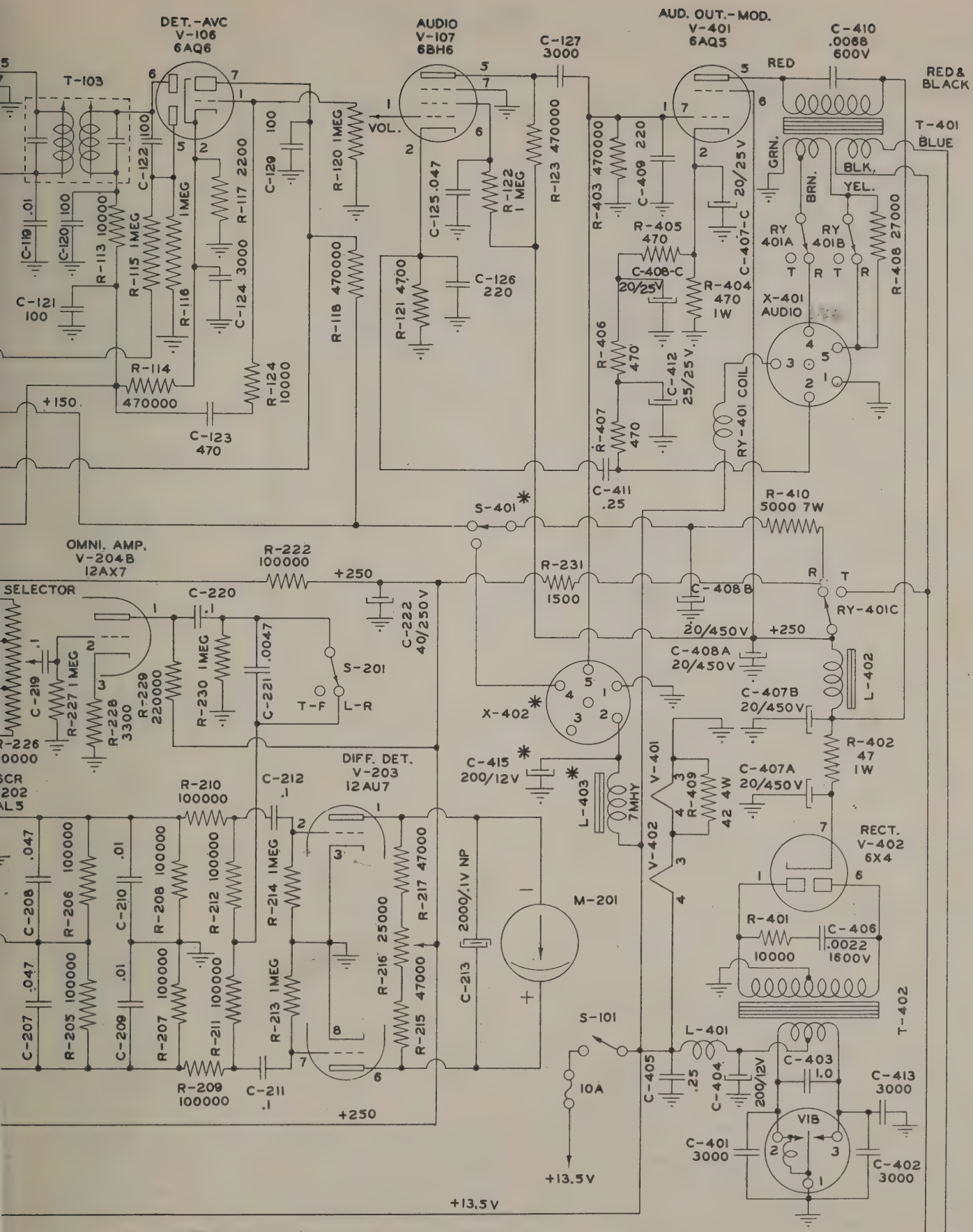


Figure 5 · SCHE


DET.-AVC
V-106
6AQ6
AUDIO
V-107
6BH6
AUD. OUT.-MOD.
V-401
6AQ5
T-103
VOL.
C-127
3000
C-410
.0068
600V
RED
RED & BLACK
T-401
BLUE
GRN.
BRN.
BLK.
YEL.
RY 401A
RY 401B
X-401
AUDIO
R-120 1MEG
R-122 1 MEG
R-123 470000
R-403 470000
C-409 220
C-407-C 20/25V
R-405 470
C-408-C 20/25V
R-404 470 1W
R-406 470
C-412 25/25V
R-407 470
RY-401 COIL
C-411 .25
R-408 27000
R-410 5000 7W
C-125 .047
C-126 220
R-121 4700
R-118 470000
C-122 100
C-119 .01
C-120 100
R-113 100000
R-115 1MEG
R-116 1MEG
C-124 3000
R-117 2200
C-129 100
C-121 100
R-114 470000
R-124 10000
C-123 470
+150
S-401
OMNI. AMP.
V-204B
12AX7
R-222 100000
+250
R-231 1500
C-408B 20/450V
C-408A 20/450V
RY-401C
SELECTOR
C-220
C-222 40/250V
S-201
T-F
L-R
C-219 .1
R-227 1MEG
R-228 3300
R-229 220000
R-230 1MEG
C-221 .0047
R-226 0000
X-402
L-402
C-407B 20/450V
C-407A 20/450V
R-402 47 1W
C-415 200/12V
L-403 7MHY
R-409 42 4W
V-401
V-402
RECT.
V-402
6X4
R-401 10000
C-406 .0022 1600V
T-402
DIFF. DET.
V-203
12AU7
R-210 100000
C-212 .1
R-214 1MEG
R-216 25000
R-217 47000
R-215 47000
C-213 2000/1V NP
M-201
C-208 .047
C-206 100000
C-210 .01
R-208 100000
R-212 100000
C-207 .047
R-205 100000
C-209 .01
R-207 100000
R-211 100000
R-213 1MEG
R-209 100000
C-211 .1
+250
S-101
10A
+13.5V
L-401
C-405 .25
C-404 200/12V
C-403 1.0
C-413 3000
VIB
C-401 3000
C-402 3000
+13.5V
+250 (XMIT)
XMIT MOD.

Section IV · · · Maintenance

A. Alignment Procedure

(See Figs. 9 and 10)

A-1 VHF Receiver Section

1. Connect a signal generator to the grid of the first I.F. stage. Keep leads short.
2. Connect an audio output meter to the PHONES output jack.
3. Set signal generator to 8.5 mc. and reduce output until audio meter reads conveniently with volume control fully advanced.
4. Peak the tuning screws on the three rear I.F. transformers. Do not peak the front I.F. transformer at this time.
5. Remove the I.F. signal generator, and connect an R.F. signal generator set to 118 mc. to the receiving antenna receptacle. See Figure 8.
6. Tune in the signal and peak the front I.F. transformer and the two rear R.F. trimmers. See Figure 10. It may be necessary to retune the set slightly while adjusting the center R.F. trimmer.
7. Reset the oscillator trimmer (front) only if the dial is badly in error, and a signal of known frequency accuracy is available.

A-2 VHF Transmitter Section

1. Set the transmitter frequency switch to 122.5.
2. Connect a 50-ohm dummy antenna to the transmitter output receptacle.
3. Connect a high-impedance DC voltmeter across R-302. Insert a 100,000-ohm isolating resistor at probe end, if probe does not contain a capacity isolating resistor.
4. Press mike button, and adjust L-302 for maximum DC voltage across R-302.
5. Press mike button and adjust L-303 for maximum DC voltage across R-302, and then back it off one full turn.
6. When properly peaked and at 13.5 volts input, the DC voltage across R-302 should lie between 35 and 45 volts.
7. Press mike button, and adjust L-301 for maximum R.F. output as indicated by a field strength meter located in the field of the transmitting antenna. The output lamp, LM-301,can be used for this purpose, but a field strength meter is better suited.

CAUTION: IT IS POSSIBLE TO BURN OUT THE OUTPUT LAMP BY OPERATING THE TRANSMITTER WITHOUT EITHER AN ANTENNA OR A 50-OHM DUMMY ANTENNA CONNECTED TO IT.

A-3 Omni-Range Section

a. METER CENTER ADJUSTMENT

1. Turn on set and tune to point where no omni signal is being received. Be sure DC supply to set lies between 13 1/4 and 13 3/4 volts.
2. Carefully set METER CENTER adjustment (R-216) to accurately center needle in scale triangle.

b. DISCRIMINATOR TRANSFORMER (T-201)

1. Connect a high-impedance DC voltmeter from ground to pin 1 of V-202 (12AL5).
2. Connect the R.F. output of an omni-signal generator (such as the NARCO T-3) to the receiver antenna jack and tune in the signal.
3. Adjust the bottom tuning screw of the discriminator transformer (T-201) for maximum DC voltage.
4. Reconnect the high-impedance voltmeter from pin 1 of V-202 to pin 5 of V-202.
5. Adjust the top tuning screw of the discriminator transformer for zero DC voltage.
6. Repeat steps 3, 4 and 5 as needed.
7. See paragraph E-4 for final adjustment procedure for the top tuning screw.

B. Voltage, Resistance and Phase Angle Charts

B-1 VHF Receiver

TUBE	PIN	DC VOLTS ①	OHMS ②
V-101	1	----	3 meg.
6BH6	2	+ 0.9	150
R.F.	3	+ 13.4	----
	4	+ 6.7	----
	5	+125	450 ③
	6	+125	600 ③
	7	0	0
V-102	1	0	0
6BH6	2	+ 1.5	470
CONV	3	+ 6.7	----
	4	+ 13.4	----
	5	+130	300 ③
	6	+ 80	47000 ③
	7	0	0
V-103	1	0	100K
6BH6	2	0	0
OSC	3	0	0
	4	+ 6.6	----
	5	+125	450 ③
	6	+125	450 ③
	7	0	0
V-104	1	----	3 meg.
6BH6	2	+ 1.5	470
First I.F.	3	0	0
	4	+ 6.7	----
	5	+127	150 ③
	6	+127	150 ③
	7	0	0
V-105	1	0	0
6BH6	2	+ 1.9	470
Second I.F.	3	+ 6.7	----
	4	+ 13.4	----
	5	+130	0 ③
	6	+130	----
	7	0	0
V-106	1	----	1 meg.
6AQ6	2	+ 0.5	2200
DET-AVC	3	0	0
OMNI AMP	4	+ 6.7	----
	5	----	1 meg.
	6	----	470K
	7	+ 45	470K ③
V-107	1	----	1 meg. ④
6BH6	2	+ 2.5	4700
AUDIO AMP	3	0	0
	4	+ 6.7	----
	5	+ 60	470K ⑤
	6	+ 85	1 meg. ⑤
	7	0	0

① Measured to ground, except where noted, with high-impedance voltmeter (Voltohmyst, or equal), and with 13.5 volts input to set.

② Measured to ground, except where noted, power off.

③ Measured to pin 6 of V-105.

④ With volume control set at maximum volume.

⑤ Measured to pin 6 of V-401.

B-2 Omni-Range Section

TUBE	PIN	DC VOLTS①	OHMS ②	AC VOLTS⑤	Phase Angle⑦
V-201	1	---	1 meg.	4.0 ⑧	---
6BH6	2	0	0	0	---
LIMITER	3	+ 6.7	---	---	---
	4	+ 13.4	---	---	---
	5	+125	27K ⑤	25 ⑥	---
	6	+ 75	74K ⑤	---	---
	7	0	0	0	---
V-202	1	---	70K ⑨	2.0	188° ⑩
12AL5	2	---	150 ⑨	8.0 ⑥	---
DISCRIM-	3	0	0	---	---
INATOR	4	+ 13.4	---	---	---
	5	---	70K ⑨	2.0	8° ⑩
	6	---	---	---	---
	7	---	160 ⑨	8.5 ⑧	---
V-203	1	+ 45	35K ⑤	---	---
12AU7	2	---	1 meg.	0.8	0° ⑩
DIFFER-	3	0	0	0	---
ENTIAL	4	0	0	---	---
DETECTOR	5	+ 13.4	---	---	---
	6	+ 45	35K ⑤	---	---
	7	---	1 meg.	0.8	180° ⑩
	8	0	0	0	---
	9	---	---	---	---
V-204	1	+135	220K ⑤	4.0	118° ⑪
12AX7	2	---	1 meg.	0.3	285° ⑪
OMNI-AMP	3	+ 1.3	3300	0.18	282° ⑪
	4	0	0	---	---
	5	+ 13.4	---	---	---
	6	+140	100K ⑤	0.30	140° ⑪
	7	+ 5	1 meg.	0.33	38° ⑪
	8	+ 7.8	11500	0.27	50° ⑪
	9	---	---	---	---

B-3 VHF Transmitter

TUBE	PIN	DC VOLTS ①	OHMS ②
V-301	1	+210 ⑫	600 ⑬
6J6	2	+210 ⑫	600 ⑬
XMTR	3	+ 13.4	---
OUTPUT	4	+ 6.7	---
	5	---	10K
	6	---	10K
	7	0	0
V-302	1	+220 ⑫	0 ⑬
6J6	2	+220 ⑫	---
XMTR	3	+ 6.7	---
OSC and	4	0	0
DOUBLER	5	---	100K
	6	---	27K
	7	0	0

B-4 Power Supply Section

TUBE	PIN	DC VOLTS ①	OHMS ②
V-401	1	---	470K
6AQ5	2	+ 15	470
AUDIO	3	0	0
OUTPUT and	4	+ 6.7	---
MODULATOR	5	+240	500 ⑤
	6	+240	---
	7	---	470K
V-402	1	325 ⑭	
6X4	2	---	---
RECT	3	+ 6.7	---
	4	+ 13.4	---
	5	---	---
	6	325 ⑭	
	7	+250	340 ⑤

① Measured to ground, except where noted, with high-impedance voltmeter (Voltohmyst, or equal), and with 13.5 volts input to set.

② Measured to ground, except where noted, power off.

③ Measured to pin 6 of V-105.

④ With volume control set at maximum volume.

⑤ Measured to pin 6 of V-401.

⑥ Measured with NARCO T-4 Filter-Voltmeter, or Ballantine Model 300 Voltmeter with X10 Multiplier.

⑦ Measured with NARCO T-3 Omni-Simulator and T-4 Filter-Voltmeter.

⑧ 9960-cycle signal.

⑨ Measured to terminal E of T-201.

⑩ Measured with V-204 removed from its socket.

⑪ Omni signal generator set to 0° omni course and course selector set to 0°. (Be sure V-204 is replaced).

⑫ Transmit only (mike switch closed).

⑬ Measured to pin 2 of V-302.

⑭ AC voltage.

C. Activation of Additional Transmitter Channels

There are sockets provided for four quartz crystals, two of which are normally supplied as original equipment. The remaining two may be selected from the following list. A space is provided on the panel to mark in the added channels.

FREQUENCY	PART NO.	USE
121.5 mc.	K-72002-1	EMERGENCY only
121.7	K-72002-2	GROUND CONTROL
121.9	K-72002-3	GROUND CONTROL
* 122.1	K-72002-4	AIRWAYS COMMUN. (RANGE)
122.3	K-72002-5	AIRWAYS COMMUM. (RANGE)
* 122.5	K-72002-6	CONTROL TOWER
122.7	K-72002-7	CONTROL TOWER
122.8	K-72002-12	UNICOM
122.9	K-72002-8	CONTROL TOWER
123.1	K-72002-13	FLIGHT TEST and FLYING SCHOOL

* Supplied with set.

Realignment of the transmitter coils should not be required when crystals in the above list are added or changed, but it is advisable to check operation on all channels and realign if necessary. The crystal oscillator should be tuned for maximum output on the highest frequency channel activated, and the tuning screw backed out one turn from this peak setting. The remaining coils should be peaked on the 122.5-mc. channel.

D. Installation of VRP-31 Parts for Low-Frequency Receiver (See Fig. 11)

1. Remove front trim panel from set, and drill 3/8" diameter hole in trim panel at center-punch mark already provided on back surface 1 3/8" directly below the transmitter monitor lamp hole center.
2. Install the push-pull switch in the holes already provided in the front support panel using 4-40 screws and lockwashers as supplied.
3. Install the filter choke in the holes already provided in the side panel (under the chassis level) using 6-32 screws, nuts and lockwashers as supplied. Mount the tie lug under the rear nut, as shown.
4. Install the new receptacle in the holes already provided in the rear apron of the chassis using 6-32 screws, nuts and lockwashers as supplied.

5. Connect the wires and install the electrolytic capacitor as shown in Figure 11, and as starred items on the schematic diagram, Figure 5.
6. Replace the trim panel, and install the small knob on the switch tongue.

E. Omni Compensation

There are three course selector dial settings at which course compensations can be made. These are 240°, 120° and 0°. The circuitry requires that they be made in that particular order if interactions are to be reduced to a minimum. It is absolutely necessary to use an approved omni signal generator, such as the NARCO T-3, ARC H-14 or Collins 479S. Be sure meter centers properly when signal is being received. (See paragraph A-3a).

E-1 Course Compensation at 240°

1. Set the omni signal generator to 240° TO and connect it to the receiver antenna jack.
2. Tune in the omni signal and set the course selector to 240°. Be sure TO-FROM flag is switched away from the meter. Use a 500-microvolt signal.
3. If error is greater than 5°, shunt R-232 to correct compensation. This resistor is located near L-302.

E-2 Course Compensation at 120°

1. Check and recompensate 240° course as needed.
2. Reset the omni signal generator to 120° TO.
3. Reset the course selector dial to 120°.
4. If the error is greater than 5°, shunt R-225 or C-218 to correct compensation. These components are on the under-chassis terminal board.

E-3 Course Compensation at 0°

1. Check and recompensate 240° course as needed.
2. Reset the omni signal generator dial to 0° TO.
3. Reset the course selector dial to either limit of its travel.
4. If the error is greater than 5°, shunt R-224 or C-217 to correct compensation. These components are likewise on the under-chassis terminal board.

E-4 Reciprocal Course Compensation

This compensation is made to eliminate differences between reciprocal courses.

Be sure 10-kc. subcarrier of simulated omni signal is adjusted accurately to 9960 cycles.

1. Set the omni signal generator to 180° FROM and the course selector dial to center the L-R meter at or near 180°.
2. Reset the omni signal generator to 0° FROM, but do not move the course selector dial.
3. If the error is greater than 5°, readjust the top tuning screw of the discriminator transformer (T-201) until the meter centers at some fixed course selector setting near 180° for both the 0° FROM course and the 180° FROM course as set on the signal generator.
4. Recheck course compensations (E-1, E-2 and E-3) and correct if necessary.

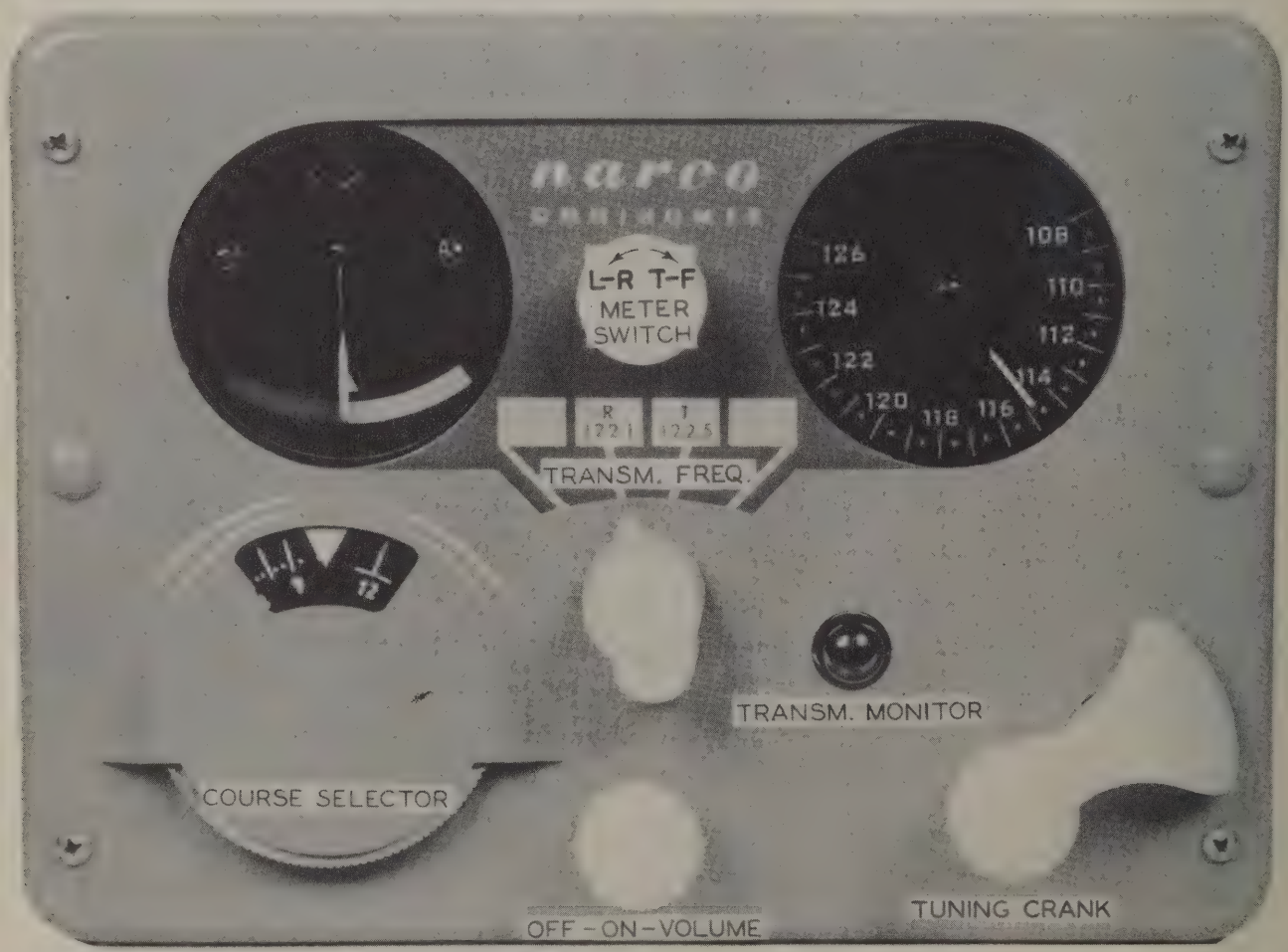


Figure 7 · FRONT VIEW

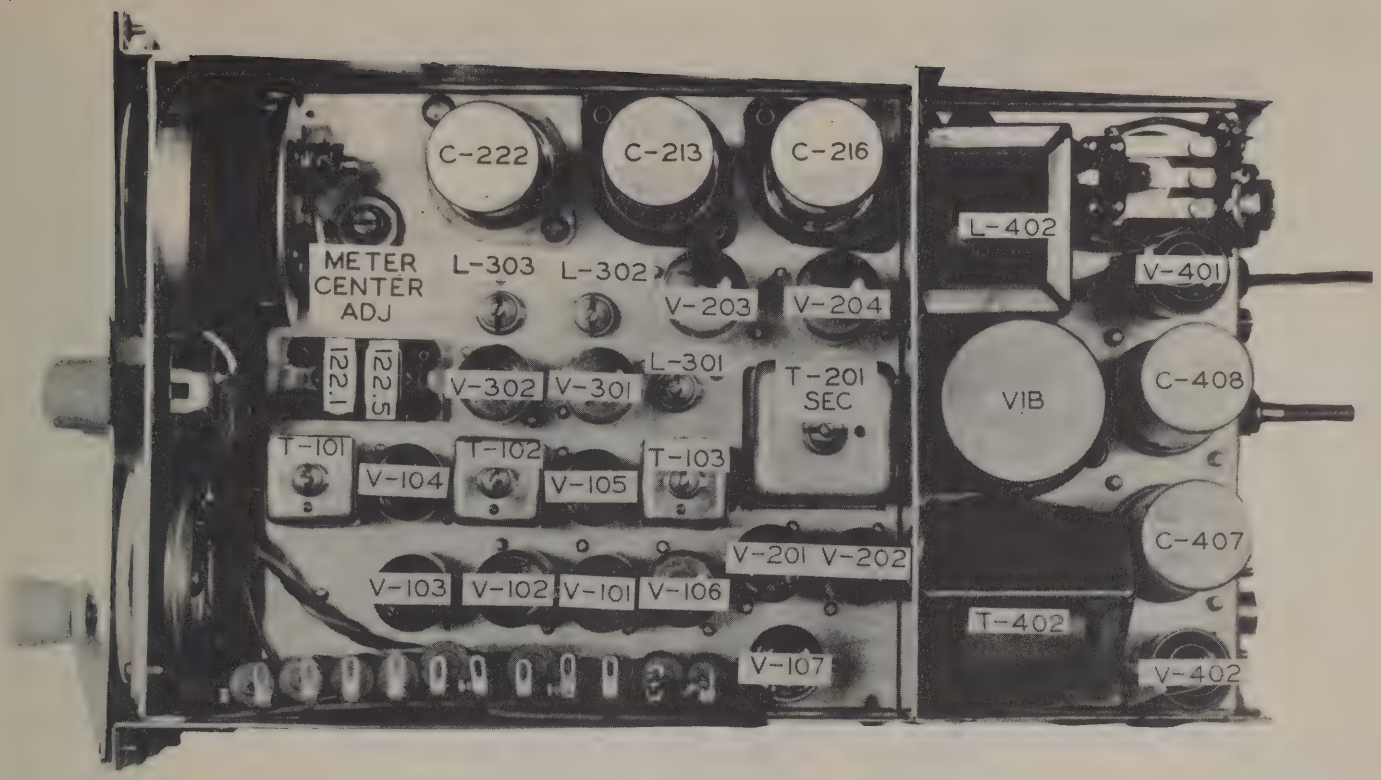


Figure 8 · REAR VIEW

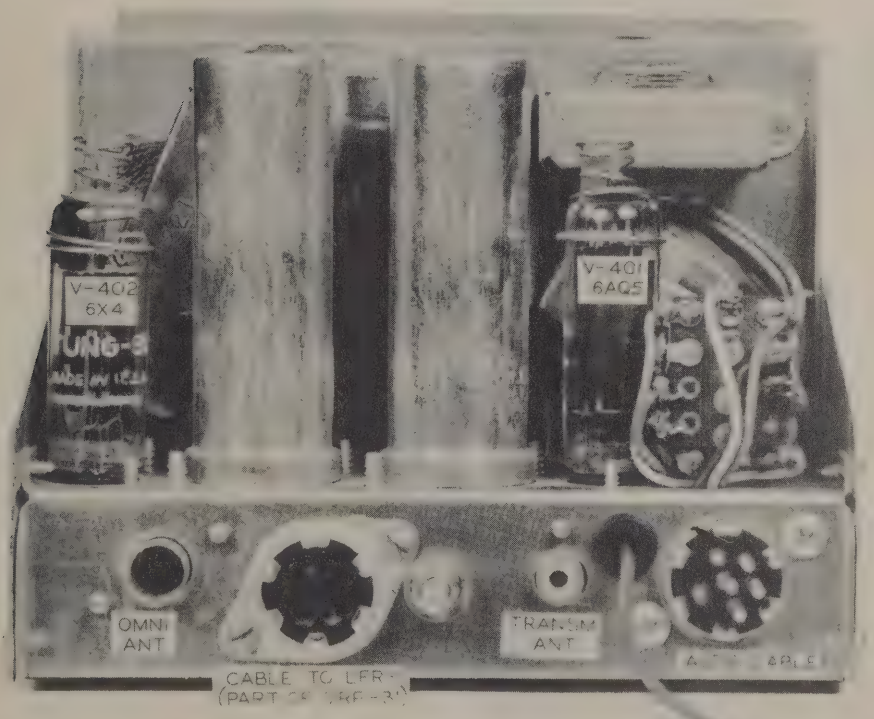


Figure 9 · TOP VIEW

F. Replacement Parts List

SYMBOL	PART NO.	DESCRIPTION
C-101, 102, 103	K-22001-525	Capacitor, Ceramic Trimmer 5 - 25 Mmf.
C-108	K-21207-479	" " 500 v N750 4.7 "
C-301	K-21201-689	" " " NPO 6.8 "
C-105, 107, 109, 303, 304	K-21201-220	" " " " 22 "
C-104, 120, 121, 122, 129, 305	K-21208-101	" " " GP 100 2
C-126, 201, 202, 409	K-21208-221	" " " " 220 "
C-106, 123, 306, 307, 308	K-21208-471	" " " " 470 "
C-302	K-21143-471	" " 1000 v " 470 "
C-110, 112, 113, 124, 127, 401, 402, 413	K-21217-302	" " 500 v " 3000 "
C-406	K-21161-332	" Tubular 1600 v .0033 Mfd.
C-214, 221	K-21425-472	" " 200 v .0047 "
C-410	K-21155-682	" " 600 v .0068 "
C-111, 115, 116, 118, 119, 128	K-21163-103	" Metallized 200 v .01 "
C-209, 210	K-21429-103	" Tubular 400 v .01 "
C-205, 206	K-21152-123	" " 200 v .012 "
C-114, 117, 125, 203, 204, 207, 208, 215	K-21429-473	" " 400 v .047 "
C-211, 212, 219, 220	K-21429-104	" " 400 v .1 "
C-405, 411	K-21163-254	" Metallized 200 v .25 "
C-217, 218, 403	K-21163-105	" " 200 v 1.0 "
C-407, 408	K-21525-202020	" Electrolytic 450-20 v 20-20-20 "
C-216, 222	K-21518-40	" " 250 v 40 "
C-404, 414	K-21510-20012	" " 12 v 200 "
C-213	K-21511-2000	" " 0.1 v NP 2000 "
C-412	K-21510-2525	" " 25 v 25 "
L-101, 102, 103	M-52016-101	Tuning Coil Assembly (with trimmer)
L-104, 304	K-11138-1	R.F. Choke, plate type
L-301	K-11224	Transmitter Output Coil Assembly
L-302	K-11223	" Doubler " "
L-303	K-11222	" Oscillator Coil Assembly
L-105	K-11138-2	R.F Choke, filament type
L-401	K-11174-1	Hash Choke
L-402	K-11173-1	Filter Choke, 4 hy.
L-403	K-11215	" " 6 mhy
LM-301	---	Panel Lamp, Mazda No. 49
M-201	M-76016	Left-Right and To-From Meter
R-102, 103, 107, 110, 111, 301	K-31110-151	Resistor, Carbon 1/2 watt 150 ohms
R-105, 109, 112, 405, 406, 407	K-31110-471	" " " 470 "
R-211, 231	K-31110-152	" " " 1500 "
R-117	K-31110-222	" " " 2200 "
R-228	K-31110-332	" " " 3300 "
R-224	---	" " " 3300 " selected
R-121	K-31110-472	" " " 4700 "
R-113, 124, 302, 401	K-31110-103	" " " 10000 "
R-220	K-31115-103	" " " 10000 " ±5%
R-225	---	" " " 10000 " selected
R-223	K-31115-153	" " " 15000 " ±5%
R-204, 303, 408	K-31110-273	" " " 27000 "
R-106, 203, 215, 217	K-31110-473	" " " 47000 "
R-101, 104, 205 to 212, 222, 304	K-31110-104	" " " 100000 "
R-229	K-31110-224	" " " 220000 "
R-114, 118, 123, 403	K-31110-474	" " " 470000 "
R-108, 115, 116, 122, 201, 202, 213, 214, 219, 227, 230	K-31110-105	" " " 1 meg
R-218	---	" " " " selected
R-404	K-31113-471	" " 1 watt 470 "
R-402	K-31125-470	" Wire " 47 "
R-409	K-31118-420	" " 4 watt 42 "
R-410	K-31119-502	" " 7 " 5000 "
R-216	K-32006-253	Potentiometer 25000 " linear
R-226	K-32012	" 300000 " special
R-120, S-101	K-32013	" 1 meg Audio w/switch
RY-401	K-65111-1	Relay, 12-volt coil
S-201	K-61125	Switch, rotary. TO-FROM
S-301	K-61123	" " Crystal selector
S-401	K-61119	" push-pull (for LFR-1)

SYMBOL	PART NO.	DESCRIPTION
T-101, 102, 103	K-11225	Transformer, I.F. 8.5 mc.
T-201	K-11170	" Discriminator
T-401	M-11166	" Audio Output
T-402	K-11221	" Vibrator (12-volt)
V-101 to 105, 107, 201	---	Tube, 6BH6
V-106	---	" 6AQ6
V-202	---	" 12AL5
V-203	---	" 12AU7
V-204	---	" 12AX7
V-301, 302	---	" 6J6
V-401	---	" 6AQ5
V-402	---	" 6X4
VIB	K-64004	Vibrator, 12-volt, 180 cycles
X-101	K-41143	Receptacle, Receiver Antenna
X-301	K-41110-2	" Transmitter Antenna
X-401	K-41112-6M	" 6-pin male
XT-301 to 304	K-72002-1	Crystal, Quartz, for 121,5 mc. (Emergency)
	K-72002-2	" " " 121.7 mc. (Ground Control)
	K-72002-3	" " " 121.9 mc. " "
	K-72002-4	" " " 122.1 mc. (Range)
	K-72002-5	" " " 122.3 mc. "
	K-72002-6	" " " 122.5 mc. (Tower)
	K-72002-7	" " " 122.7 mc. "
	K-72002-8	" " " 122.9 mc. "
	K-72002-12	" " " 122.8 mc. (Unicom)
	K-72002-13	" " " 123.1 mc. (Flight Test)
	K-41127-1	Jack, Phone
	K-41128-1	" Mike
	P-51701	Case, Transmitter-Receiver Unit
	P-52001	Front Trim Panel
	M-88004	Tuning Crank Assembly
	K-88010	Knob, pointer type
	K-88009	" volume control type
	K-88026	Course Selector Dial Assembly
	K-41151	Crystal Socket Assembly
	M-88019	Tuning Pinion and Stop Washer Assembly
	K-42002-1	Tube Socket, 7-pin miniature, phenolic
	K-42002-2	" " " " ceramic
	K-42003-1	" " 9-pin " phenolic
	K-42004-4	" " 4-pin wafer (vibrator)
	K-41147	Lamp Socket, pilot
	K-88031	Dial Cord
	K-88030-102	Pulley Assembly
	M-88017	Dial Scale

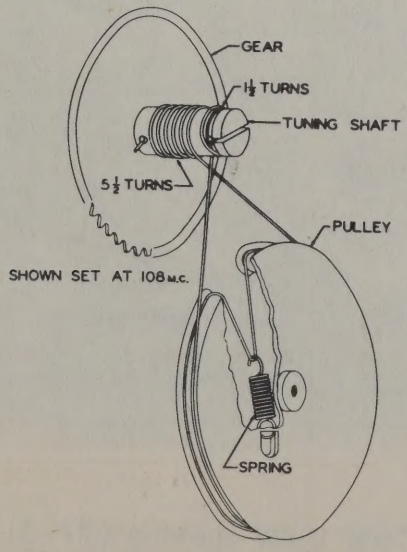


Figure 6 · DIAL STRINGING DIAGRAM

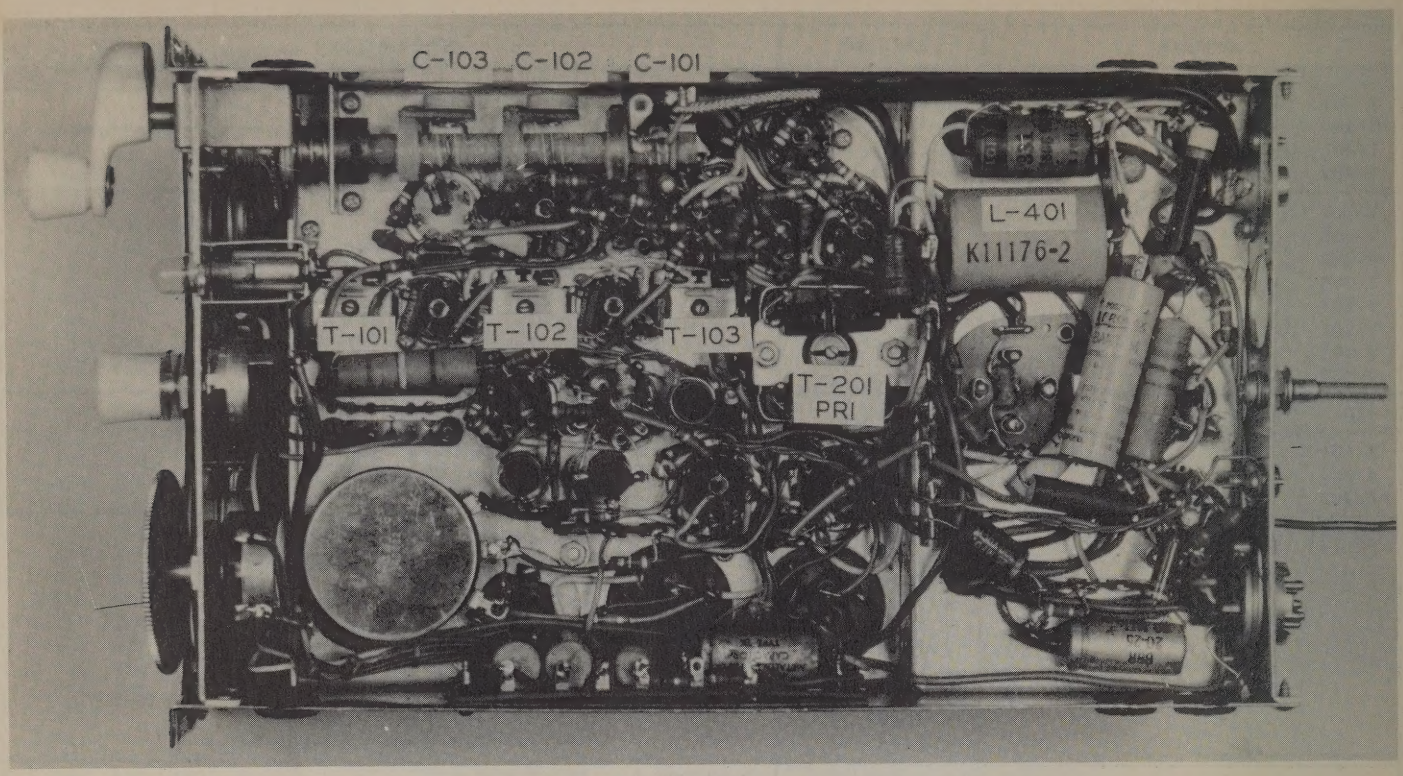


Figure 10 · BOTTOM VIEW

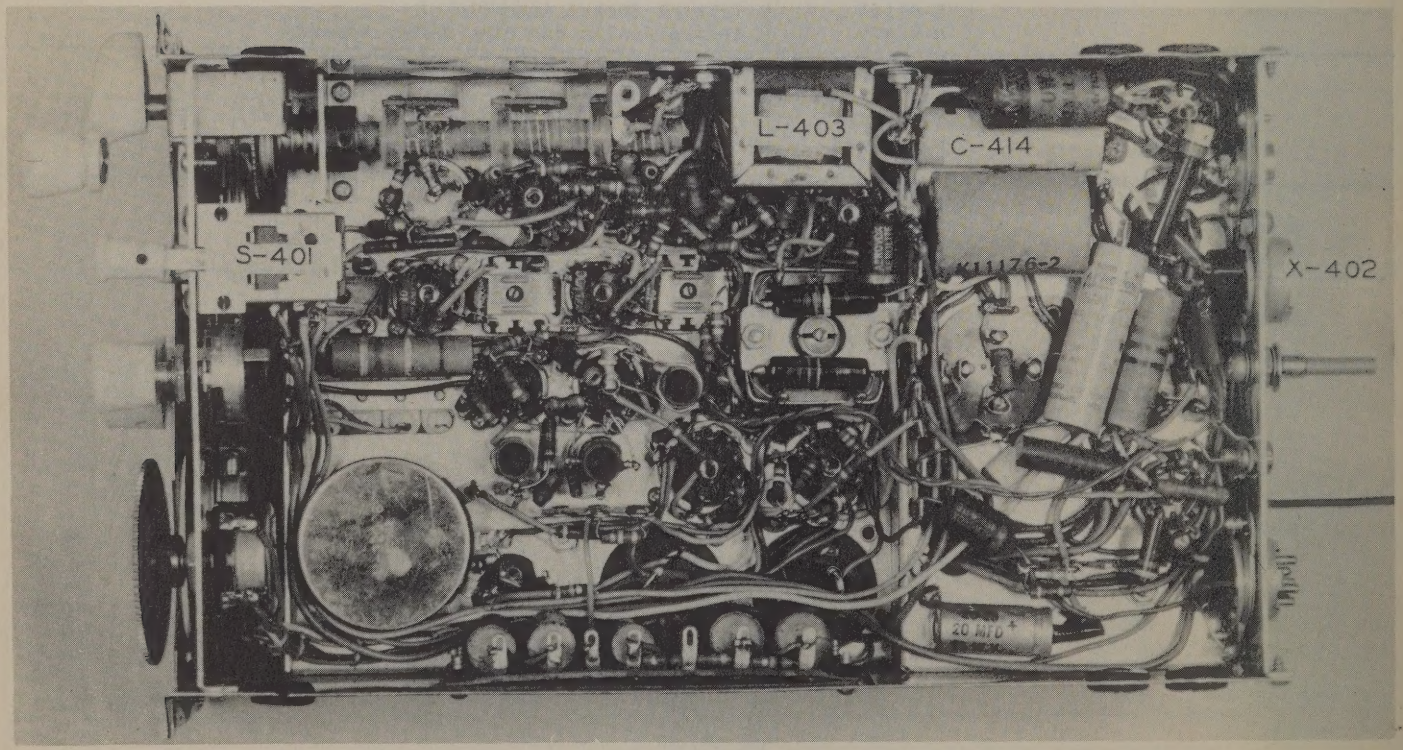


Figure 11 · BOTTOM VIEW showing VRP-31 PARTS